Stubble-Summerfallow Yield Ratios of Crops Grown in Saskatchewan: 1958 to 1978

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My interest in stubble-summerfallow yield ratios developed because of the research activities of the Institute's personnel in a number of areas. Our recent work in land evaluation (Halstead, 1978 and Kraft, 1979a), crop modelling (Ward, 1979), and productivity of areas scheduled to lose rail service (Kraft, 1979b, 1979c) explicitly involved stubble and summerfallow yields of the principle crops grown in the province. In addition, our concern with land degradation and subsequent recommendations for increased stubble cropping all involve implicit consideration of stubble-summerfallow yield ratios (Rennie and Ellis, 1978). In the long run, the economic and agronomic viability of longer rotations will be determined partially by the productivity of crops grown under stubble conditions. While our research activities made us aware of the importance of stubble and summerfallow yields and the ratio between them, we were unable to find any comprehensive analysis of these data for the province or for areas within the province. Consequently, the present research was undertaken to study trends associated with these yields and ratios. In addition, the research was designed to give us experience with different sets of data and provided an opportunity to evaluate the degree of similarity among these data sets.

There are available within Saskatchewan three sets of data containing data on stubble yields, summerfallow yields, and stubble-summerfallow yield ratios. Data provided by Statistics Canada (Statistics Canada) are based on an annual mail survey of a sample of 4000 provincial farmers. The sample is constructed on the basis of rural municipalities; however, the published data are based on a process of aggregation and weighting by crop districts (Chumsky, 1980). These data are available on a provincial basis from 1958 to the present. Because of the broad based, annual sample, I assumed that these data represented the modal level of agricultural management and technology for provincial farmers.

The second set of data is the records from the Soil Test Laboratory of the Saskatchewan Institute of Pedology. These records were analyzed in 1978 for the period 1966 to 1976 (Halstead, 1978). The records were summarized by soil zone, crop, summerfallow yields, stubble yields, number of years of consecutive stubble crops, and fertilizer usage. The records used in the present study represented 15,779 yields from stubble and summerfallow fields spread over four soil zones and two crops (table 1). For any given year, the average

[1] The author would like to acknowledge the help of Elaine Wheaton, Dale Johns, and Anne Kuzub in the preparation of this report.

stubble yield reported by Halstead was used in this study. These data represent a nonrandom sample of stubble and summerfallow yields across the province. However, since they are directly associated with farmers testing their soils and using fertilizer, I assumed that there is a high probability of them representing above average managers and levels of technology. Consequently, a comparison between the data from Statistics Canada and the Soil Testing Laboratory would be valuable in uncovering different trends in the stubble-summerfallow yield ratios due to management and technology.

Table 1. Distribution of Records from the Saskatchewan Soil Testing Laboratory Used in this Study

		Soil Zone			
Crop	Stubble or Summerfallow	Brown	Dark Brown	Thin Black	Thick Black
Wheat	Stubble	552	1,157	820	363
	Summerfallow	1,620	4,470	3,397	966
Barley	Stubble	132	406	402	355
	Summerfallow	129	342	424	244

Source: Halstead, 1978 pp. 8-11.

The third data set available is from the records of the Saskatchewan Crop Insurance Board (Saskatchewan Crop Insurance Board, 1979). These data are available on an annual basis by crop and rural municipality from 1973 to the present. Since I did not have these data readily available on a spatial level comparable to the province or the soil zones, I did not use them in the study. However, the data are invaluable in studying local trends in the yield ratios across the province.

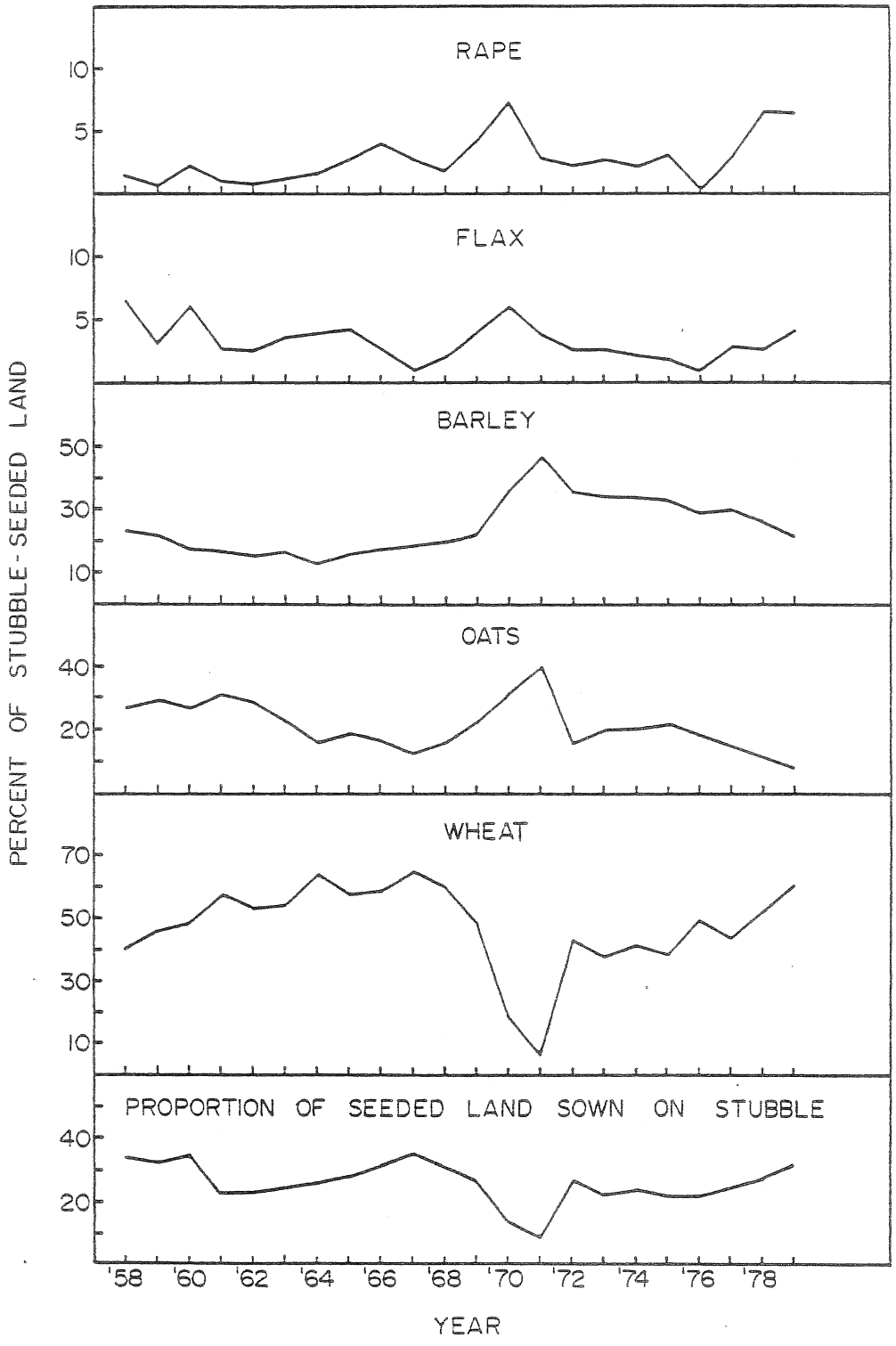
Before looking at yield ratios for specific crops, we can acquire an appreciation for the significance of the ratios by examining the role of stubble cropping in Saskatchewan. Furthermore, this examination should reveal if there are differences among crops as to the importance of stubble-summerfallow yield ratios for the amount of the crop produced provincially. Since 1958, an average of 26.2 percent of the land seeded in any year has been seeded as stubble crop (table 2 and figure 1). The range in the proportion of the stubble-seeded land is 34.8 percent in 1967 to 8.8 percent in 1971. The year 1971 reflects the impact of the federal program of Lower Inventories for Tomorrow (LIFT) in which farmers were encouraged to restrict their plantings of most cereal crops. Even considering the anomalous year of 1971, slightly more than 25 percent of all the crops seeded in Saskatchewan from 1958 to 1979 were seeded on stubble land. Data in table 2 indicate that the trend in planting stubble land has been increasing since 1971. The present levels of 32 percent correspond to the higher than average stubble plantings in the first part of the time series.

Table 2. Amount of Seeded Acreage on Stubble and Summerfallow Land and the Distribution of Stubble Land among Principle Crops: 1958-1979.

Year	Seeded Acres (1000s) Total	Summer-fallow	Stubble	Stubble seeded land as % of total	Percentage distribution of stubble-seeded land by crop Wheat	Barley	Oats	Flax	Rape
1958	22,216	14,671	7,545	34.0	40.8	23.8	27.4	6.5	1.5
1959	22,394	15,256	7,138	31.9	45.7	21.7	29.0	3.1	0.6
1960	22,758	14,905	7,853	34.5	47.7	17.0	27.0	6.1	2.2
1961	20,728	16,075	4,653	22.4	58.1	16.6	31.9	2.9	0.9
1962	22,285	17,150	5,135	23.0	52.6	15.0	28.9	2.6	0.8
1963	22,772	17,051	5,721	25.1	54.0	17.4	23.9	3.6	1.1
1964	22,893	16,868	6,025	26.3	64.5	13.4	16.3	4.1	1.5
1965	23,285	16,785	6,500	27.9	58.4	14.9	19.7	4.2	2.8
1966	24,658	16,770	7,888	32.0	59.3	17.5	16.9	2.8	3.5
1967	24,343	15,860	8,483	34.8	65.4	18.0	12.8	1.1	2.6
1968	24,218	16,614	7,604	31.4	60.4	19.2	16.2	2.3	1.9
1969	23,170	16,914	6,256	27.0	48.2	21.6	22.0	4.1	4.1
1970	16,950	14,700	2,250	13.3	18.4	36.2	31.0	6.4	8.0
1971	24,122	22,001	2,121	8.8	6.5	47.1	40.0	3.8	2.8
1972	22,340	16,500	5,848	26.2	42.8	35.3	16.8	2.5	2.4
1973	24,100	18,450	5,650	23.4	39.7	34.5	20.6	2.7	2.6
1974	22,600	17,150	5,450	24.1	40.9	34.4	20.2	2.1	2.4
1975	22,800	17,700	5,100	22.4	39.7	33.5	21.7	1.9	3.1
1976	23,200	18,000	5,200	22.4	50.0	29.6	18.6	1.0	0.1
1977	23,600	17,600	6,000	25.4	44.6	30.3	15.9	2.9	3.0
1978	24,650	17,700	6,950	28.2	53.3	26.5	11.1	2.6	6.5
1979	24,700	16,800	7,900	32.0	60.5	20.5	8.3	4.1	6.5
Average	22,945	16,887	6,058	26.2	47.80	24.73	21.65	3.34	2.77
Standard devaiation	1,670	1,544	1,659	6.45	14.13	9.08	7.64	1.51	2.00
Coefficient of variation	7.3	9.1	27.4	24.63	29.60	36.73	35.27	45.24	72.37

Source: Data derived from Statistics Canada, Quarterly Bulletin of Agricultural Statistics and Field Crop Reporting Series, various issues.

Figure 1. Use of Stubble-Seeded Land By Crop: 1958-1979.



Source: Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue 21-003 (Ottawa: Ministry of Industry, Trade, and Commerce, various issues) and Field Crop Reporting Series, Catalogue 22-002 (Ottawa: Ministry of Industry, Trade, and Commerce, various issues).

Table 2 and figure 1 indicate the proportion of stubble-seeded land that is attributable to the major crops grown in Saskatchewan. On average, wheat has accounted for slightly less than 50 percent of all the stubble seed acreage. However, wheat has traditionally accounted for about 55 to 60 percent of the total seed acreage. As in the case of all stubble-seeded land, the LIFT program resulted in some extremely low percentages for wheat. Conversely, the proportion of stubble-seeded land jumped for oats and barley during the period of LIFT. Normally, these crops account for 20 and 25 percent of the stubble-seed land respectively. For all the crops, we should note the relatively high coefficients of variation. These high coefficients indicate the large amount of variation among years as to the proportion of stubble land that is attributable to any crop.

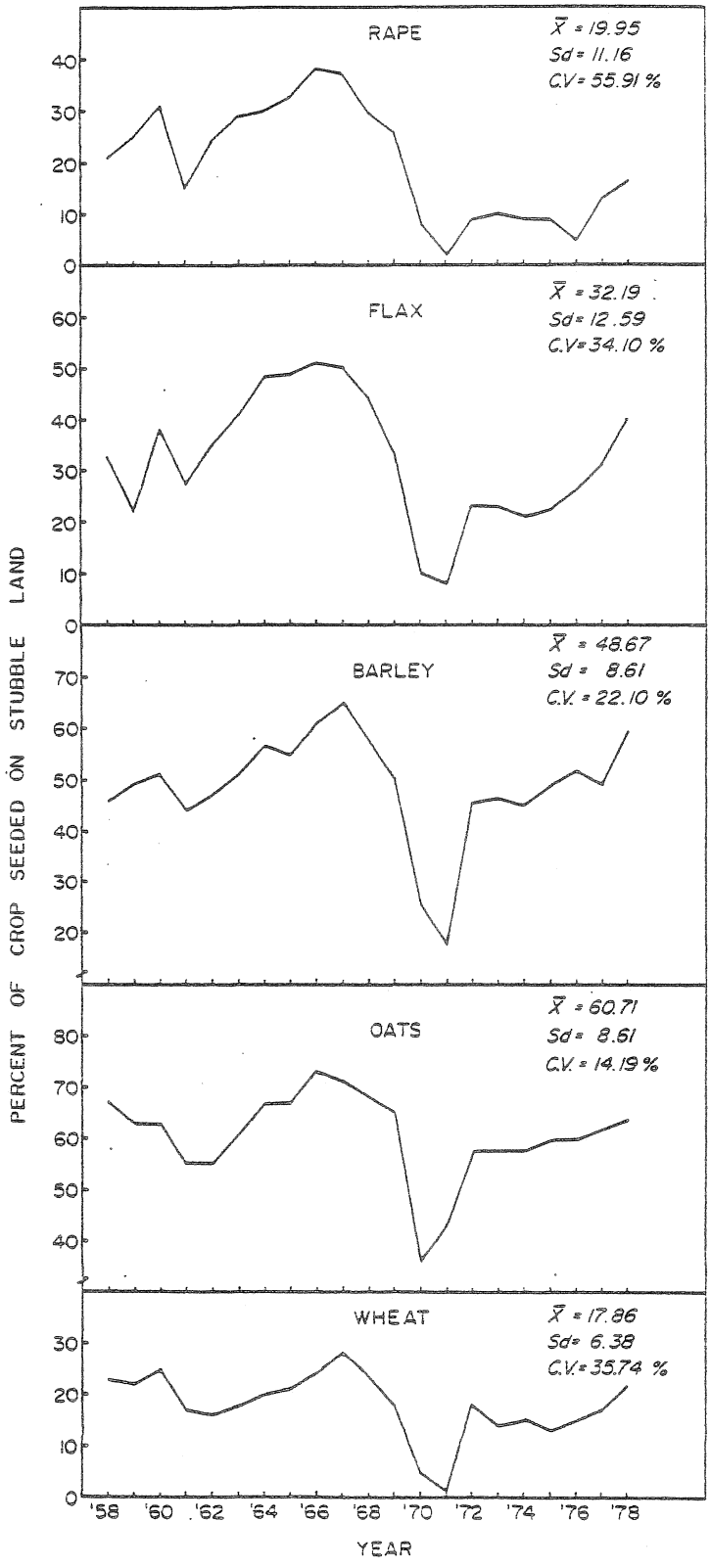
The significance of seeding on stubble land varies dramatically by crop (figure 2). This importance is reflected in the proportion of seeded acreage that is seeded traditionally on stubble land for a particular crop. In Saskatchewan, these proportions range from a low of 17.9 percent for wheat to a high of 60.7 percent for oats. Surprisingly, the proportion for oats has remained comparatively constant through time, i.e., its relatively low coefficient of variation compared to other crops. The plotted data in figure 2 indicate the effect of the LIFT program on the proportion of crops seeded on stubble land.

The preceeding data indicate the agronomic and economic importance of stubble yields is affected by two variables. The first is the proportion of all the stubble-seeded land that is accounted for by specific crops. The second is the proportion of the land seeded to a crop that is stubble land. In both cases agronomists and economists should be interested in those crops that are important to the province that either account for a large proportion of the stubble-seed land, i.e., wheat. Or, those crops that are grown extensively on stubble land, i.e., oats and barley. Flax possibly falls in this second category given its historical level of approximately 42 percent grown on stubble land and the increase in stubble plantings of flax since 1974 (figure 2). Agronomic and economic factors that affect either the agronomic response of these stubble crops or the managerial and technological decisions of farmers seeding these crops are important. There importance derives from the implications of changes in agronomic response or managerial decisions upon the total level of stubble crop productivity and the financial viability of stubble-cropping enterprises. The success of programs to reduce land degradation, to encourage longer rotations, and to introduce minimum-tillage depends on the agronomic responses of stubble seeded crops and their economic viability.

Our background information indicates that as a minimum we should examine the stubble and summerfallow yields for wheat, oats, barley and flax. While we can examine these yields in some depth on a provincial basis using data from Statistics Canada, we cannot do so on a comparative basis using data from the Soil Testing Laboratory. The latter set of data does not contain adequate observation for oats, flax, and rape for comparative purposes.

Data on provincial yields for stubble and summerfallow seeded

Figure 2. Percentage of Crops Sown on Stubble Land in Saskatchewan, 1958 - 1978.



Source: Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue 21-003 (Ottawa: Ministry of Industry, Trade, and Commerce, various issues) and Field Crop Reporting Series, Catalogue 22-002 (Ottawa: Ministry of Industry, Trade, and Commerce, various issues).

$\bar{X}$ = mean for period 1958 - 1978 Sd = standard deviation of the percentage
C.V. = coefficient of variation

land and the stubble-summerfallow yield ratios for wheat, oats, barley, flax, and rape are presented in table 3. The yield ratios are depicted in figure 3 and 5-year moving averages of the ratios are presented in figure 4. These data show, that even though the yields of the various crops on both stubble and summerfallow land fluctuate greatly, the stubble-summerfallow yield ratios for all the crops have remained remarkably stable through time. The data from Statistics Canada indicate that the yield ratio for wheat has been 68.5 percent, for oats 72.4 percent, for barley 71.6 percent, for flax 70.3 percent, and for rape 67.2 percent. The five-year moving averages (figure 4) and the coefficients of variation underscore the stability in these ratios over time. However, the increase in the ratios during the early 1960s is noteworthy. Currently, we lack sufficient data to ascribe this increasing trend to the recovery of crop yields after the dry years of the early 1960s or to the initial introduction of herbicides and other technologies that could have boosted the yield of stubble seeded crops (Petersen, 1979).

Since the mid 1960s, the trends in stubble-summerfallow yield ratios for cereal crops have been remarkably stable: wheat at 69 percent, oats at 72 percent, and barley at 72 percent. This stability was maintained in spite of large fluctuations in absolute levels of both summerfallow and stubble yields. The consistency of these yield ratios implies that both summerfallow yields and stubble yields have been responding proportionately the same to changes in climate and technology. Even though these relationships demand empirical investigation, they appear to point to the neutral effect of technology on the stubble-summerfallow yield ratios[2]. In contrast to the cereal grains, the data for rape and flax present a different pattern. Even though the stubble-summerfallow yield ratios for rape have remained constant around 67 percent, the data (table 3 and figure 3) indicate that during the last 5 years there has been a gradual increase in the ratio. For flax, the data portray much greater variability then for any of the other crops. However, similarly to rape, the yield ratio of stubble crop to summerfallow crop is gradually increasing.

Data on stubble yield, summerfallow yield, and stubble-summerfallow yield ratios for wheat and barley from the records of the Saskatchewan Soil Testing Laboratory are present in table 4 and figures 5 and 6. These data have been broken down by four soil zones: the Brown, Dark Brown, Thin Black and Thick Black. Given our earlier assumption that data from Statistics Canada represent modal yields and yield ratios and that data from the Soil Testing Laboratory represent yield and yield ratios associated with better levels of management, a comparison of these two data sets should be instructive.

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[2] Note: During a question period after presenting the paper to the Workshop, Earl Johnson of Regina pointed out that a similar situation had prevailed in Manitoba up until the time that the average level of nitrogen fertilization on stubble-seeded crops rose above a minimum level. After the rate of nitrogen fertilizer increased, the stubble-summerfallow yield ratios began to increase as well.

Table 3. Stubble Yields, Summerfallow Yields, and Stubble-Summerfallow Yield Ratios for Principle Crops: 1958-1978

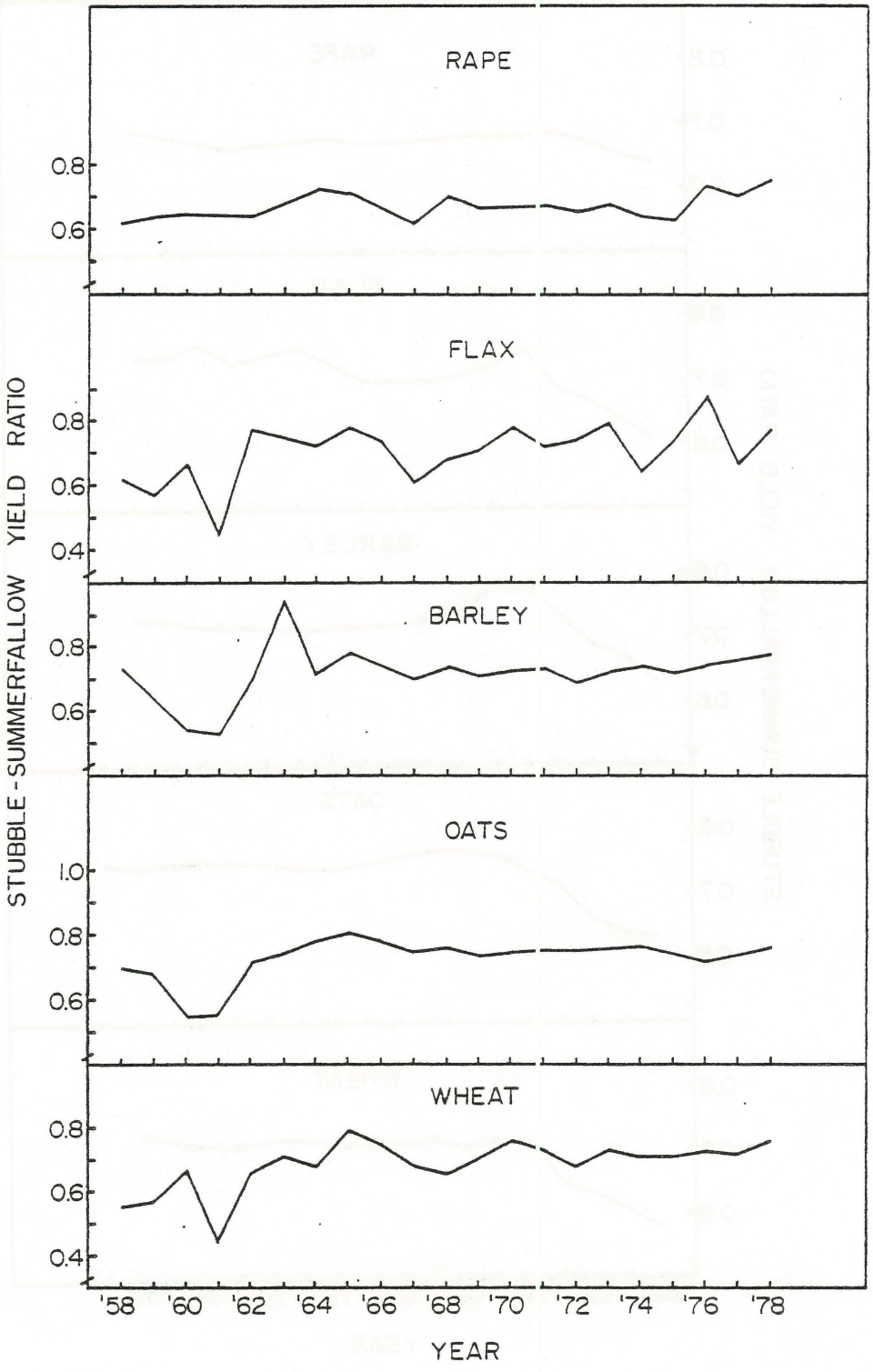
	Wheat			Oats			Barley			Flax			Rape		
Year	STB[a] Yield (Bu/Ac)	SMF[b] Yield (Bu/Ac)	Yield Ratio %	STB Yield (Bu/Ac)	SMF Yield (Bu/Ac)	Yield Ratio %	STB Yield (Bu/Ac)	SMF Yield (Bu/Ac)	Yield Ratio %	STB Yield (Bu/Ac)	SMF Yield (Bu/Ac)	Yield Ratio %	STB Yield (Bu/Ac)	SMF Yield (Bu/Ac)	Yield Ratio %
1958	9.1	16.2	56.2	23.7	34.0	69.7	18.3	25.2	72.6	5.3	8.6	61.6	8.2	13.4	61.2
1959	9.9	17.3	57.2	24.0	36.0	66.7	18.2	28.6	63.6	4.1	7.1	57.7	11.9	18.7	63.6
1960	15.2	22.6	67.3	9.6	17.8	53.9	7.6	14.2	53.5	6.5	9.9	65.7	10.6	16.3	65.0
1961	4.1	9.4	43.6	9.3	17.0	54.7	7.3	13.7	53.3	3.1	7.0	44.3	10.2	15.8	64.6
1962	14.1	21.5	65.6	34.1	48.4	70.5	24.1	34.3	70.3	8.8	11.5	75.6	11.0	17.2	64.0
1963	20.6	29.0	71.0	46.8	63.7	73.5	34.6	36.3	94.5	12.1	16.1	75.2	14.4	21.2	67.9
1964	13.1	19.4	67.5	33.6	43.0	78.1	20.8	28.9	72.0	7.2	10.0	72.0	13.8	19.1	72.3
1965	17.8	22.6	78.8	45.1	56.7	79.5	33.1	42.2	78.4	11.4	14.6	78.1	15.1	21.3	70.9
1966	22.0	29.5	74.6	46.9	60.5	77.5	37.6	50.4	74.6	11.9	16.1	73.9	13.3	19.9	66.8
1967	12.9	18.9	68.3	29.1	39.2	74.2	23.3	33.4	69.8	6.2	10.3	60.2	12.2	19.8	61.6
1968	14.1	21.3	66.2	37.4	49.4	75.7	27.6	37.8	73.0	9.2	13.5	68.1	15.5	22.1	70.1
1969	20.6	29.4	70.1	45.1	62.1	72.6	33.5	47.3	70.8	11.0	15.5	71.0	13.4	19.9	67.3
1970	20.3	26.6	76.3	46.0	62.2	74.0	46.2	33.3	72.1	13.1	16.9	77.5	12.3	18.5	66.5
1971	19.6	26.8	73.1	47.4	63.3	74.9	34.5	47.6	72.5	10.3	14.3	72.0	12.7	18.8	67.6
1972	16.8	24.9	67.5	41.0	54.8	74.8	30.9	44.7	69.1	10.9	14.7	74.1	11.3	17.1	66.1
1973	18.0	24.7	72.9	43.7	57.5	76.0	32.2	45.0	71.6	11.3	14.4	78.5	11.6	17.1	67.8
1974	15.6	21.9	71.2	34.8	45.9	75.8	26.6	36.2	73.5	6.0	9.2	65.2	10.7	16.5	64.8
1975	18.8	26.5	70.9	40.6	55.2	73.6	30.9	43.1	71.7	10.2	13.9	73.4	11.9	19.0	62.6
1976	23.9	32.8	72.9	48.9	67.5	72.4	39.5	53.3	74.1	15.4	17.6	87.5	17.1	23.1	74.0
1977	21.7	30.2	71.9	45.6	61.3	74.4	38.4	50.6	75.9	12.7	19.4	65.5	18.0	25.6	70.3
1978	23.5	30.8	76.3	46.0	59.6	77.2	38.5	50.2	76.7	15.1	19.6	77.0	18.0	23.8	75.6
Average	16.7	23.9	68.5	37.1	50.2	72.4	28.7	37.9	71.6	9.6	13.3	70.3	13.0	19.2	67.2
Standrad deviation	5.1	5.7	0.8	11.9	14.5	6.7	10.2	11.3	8.3	3.5	3.8	9.2	2.6	2.9	3.9
Coefficient of variation	30.4	24.0	11.7	32.1	28.9	9.3	35.3	29.9	11.6	36.0	28.4	13.1	20.0	15.2	5.8

Source: Statistics Canada, Quarterly Bulletin of Agricultural Statistics and Field Crop Reporting Series, various issues.

[a] STB = Stubble

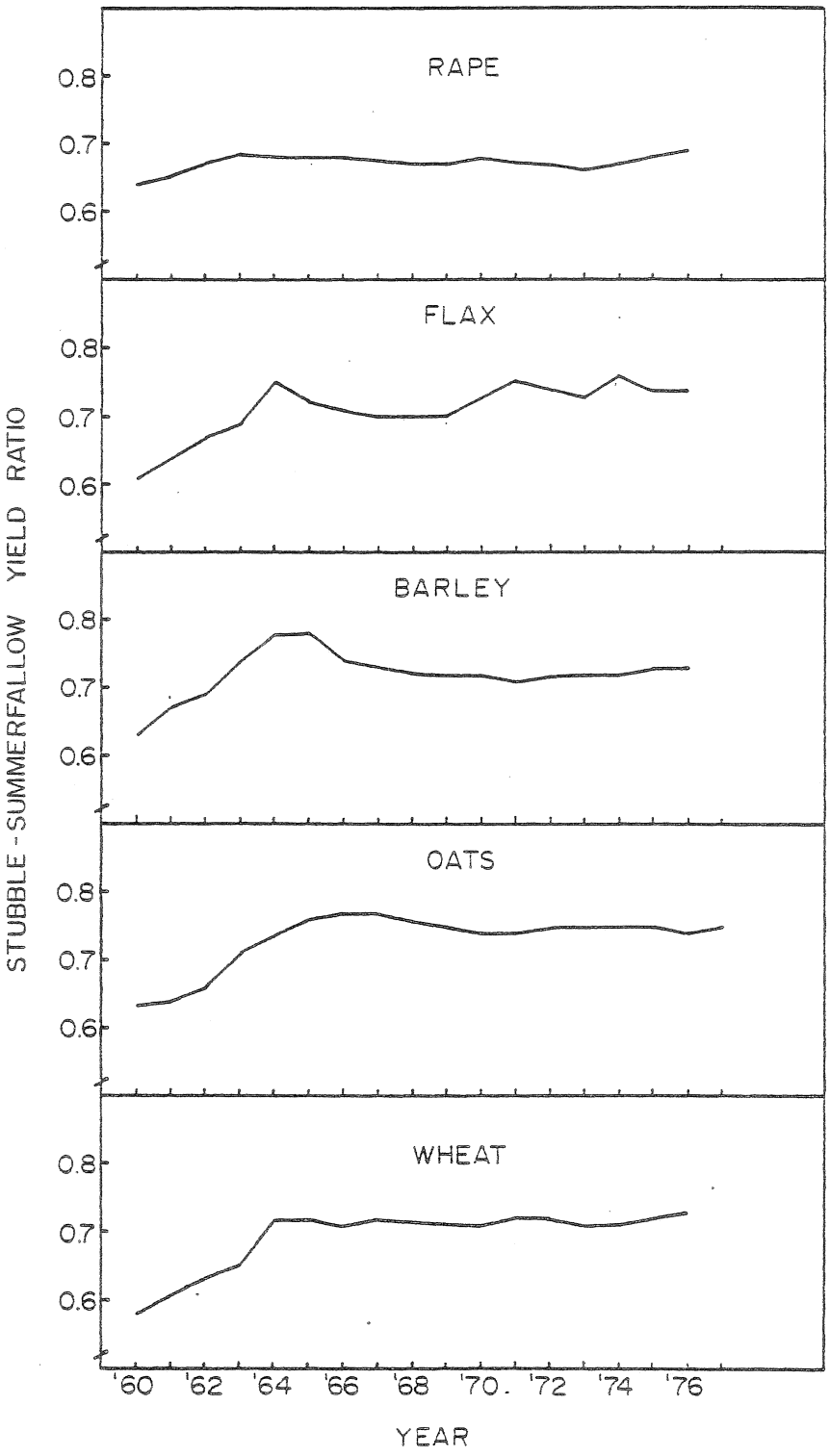
[b] SMF = summerfallow

Figure 3. Stubble-Summerfallow Yield Ratios of Field Crops Grown In Saskatchewan, 1958 - 1978.



Source: Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue 21-003 (Ottawa: Ministry of Industry, Trade, and Commerce, various issues) and Field Crop Reporting Series, Catalogue 22-002 (Ottawa: Ministry of Industry, Trade, and Commerce, various issues).

Figure 4. Five-Year Moving Averages of Stubble-Summerfallow Yield Ratios for Selected Saskatchewan Crops, 1958-1978.



Source: Statistics Canada, Quarterly Bulletin of Agricultural Statistics, Catalogue 21-003 (Ottawa: Ministry of Industry, Trade, and Commerce, various issues) and Field Crop Reporting Series, Catalogue 22-002 (Ottawa: Ministry of Industry, Trade, and Commerce, various issues).

Table 4. Stubble Yield, Summerfallow Yields and Stubble-Summerfallow Yield Ratios for Wheat and Barley, by Soil Zone: 1966-1976, Saskatchewan Soil Testing Laboratory data.

		Wheat			Barley		
Soil Zone	Year	STB[a] Yield (Bu/Ac)	SMF[b] Yield (Bu/Ac)	Yield Ratio %	STB Yield (Bu/Ac)	SMF Yield (Bu/Ac)	Yield Ratio %
BROWN	1966	23	32	71.9	31	47	66.0
	1967	15	16	93.8	20	30	66.7
	1968	14	21	66.7	25	36	69.4
	1969	16	23	69.6	50	60	83.3
	1970	25	20	125.0	40	43	93.0
	1971	n.a.	22	n.a.	31	41	75.6
	1972	20	26	76.9	48	43	111.6
	1973	20	24	83.3	36	41	87.8
	1974	21	26	80.8	31	37	83.8
	1975	25	28	89.3	27	36	75.0
	1976	27	34	79.4	35	37	94.6
Mean		20.6	24.7	83.7	34.0	41.0	82.4
Standard deviation		4.50	5.26	16.8	9.2	7.8	90.8
Coefficient of variation		21.9	21.3	20.1	27.0	19.0	110.1
DARK BROWN	1966	23	29	79.3	35	51	68.6
	1967	16	21	76.2	23	35	65.7
	1968	18	22	81.8	27	39	69.2
	1969	21	31	77.4	25	50	50.0
	1970	25	25	100.0	55	44	125.0
	1971	23	31	74.2	38	51	74.5
	1972	24	28	85.7	34	52	65.4
	1973	24	28	85.7	32	45	71.1
	1974	20	27	74.1	29	42	69.0
	1975	24	28	85.7	38	45	84.4
	1976	30	33	90.9	40	50	80.0
Mean		22.55	27.55	81.9	34.18	45.82	74.8
Standard deviation		3.75	3.70	9.0	8.89	5.56	18.8
Coefficient of variation		16.6	13.4	11.0	26.0	12.1	25.2

Continued

Table 4 continued

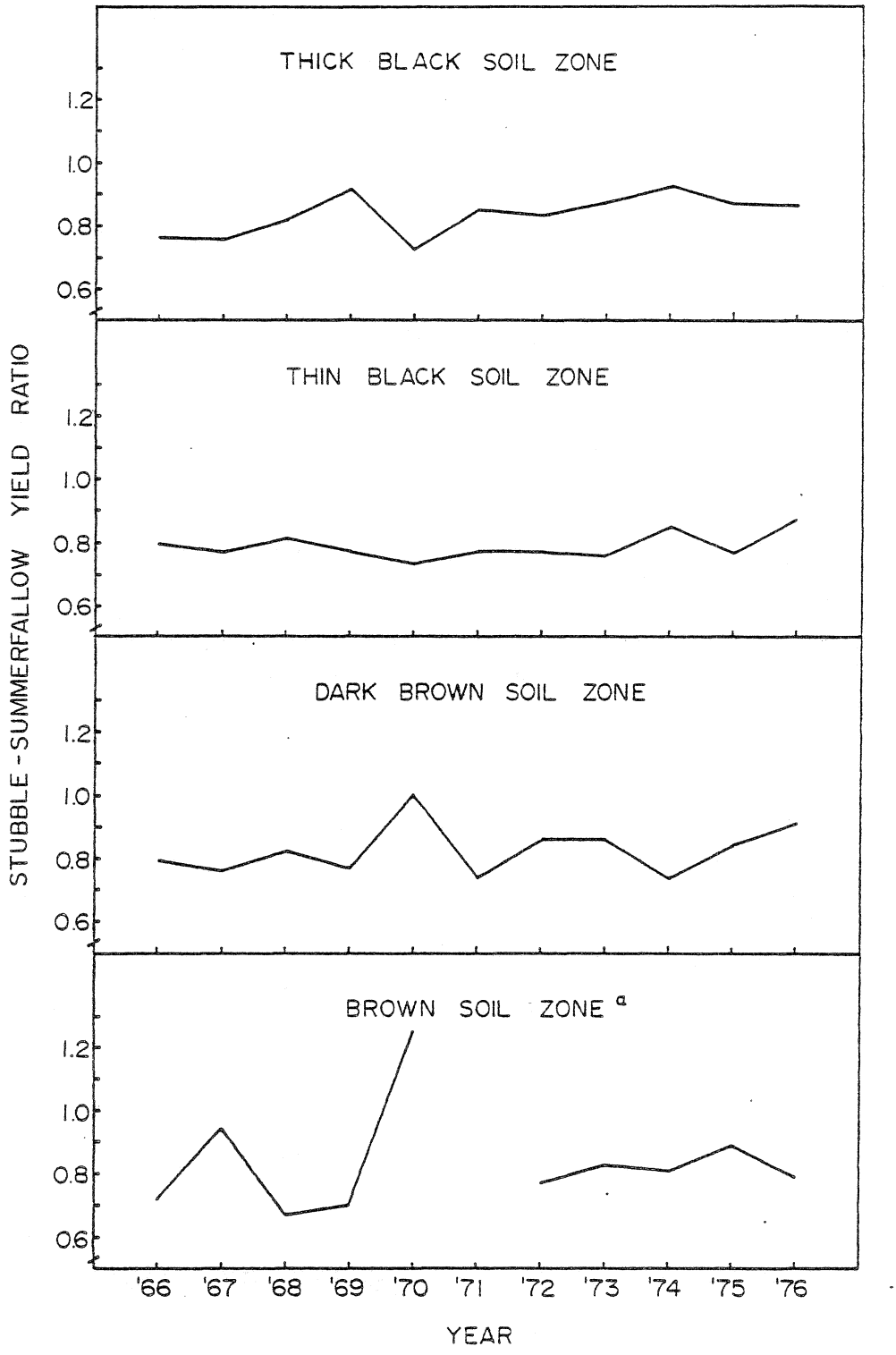
Soil Zone	Year	Wheat STB[a] Yield (Bu/Ac)	Wheat SMF[b] Yield (Bu/Ac)	Wheat Yield Ratio %	Barley STB Yield (Bu/Ac)	Barley SMF Yield (Bu/Ac)	Barley Yield Ratio %
THIN BLACK	1966	26	33	78.8	38	55	69.1
	1967	20	26	76.9	29	43	67.4
	1968	21	26	80.8	36	42	85.7
	1969	26	34	76.5	40	63	63.5
	1970	22	30	73.3	36	53	67.9
	1971	27	35	77.1	40	53	75.5
	1972	24	31	77.4	42	50	84.0
	1973	25	33	75.8	41	53	77.4
	1974	24	28	85.7	37	46	80.4
	1975	24	31	77.4	36	48	75.0
	1976	30	34	88.2	46	51	90.2
Mean		24.46	31.00	78.9	38.27	50.64	76.0
Standard deviation		2.84	3.19	0.4	4.36	5.92	8.5
Coefficient of variation		11.6	10.3	5.6	11.4	11.7	11.2
THICK BLACK	1966	28	37	75.7	44	58	75.9
	1967	19	25	76.0	26	36	72.2
	1968	27	33	81.8	43	55	78.2
	1969	36	39	92.3	45	54	83.3
	1970	26	36	72.2	40	60	66.7
	1971	35	40	87.5	38	64	59.4
	1972	30	36	83.3	45	55	81.8
	1973	30	34	88.2	40	54	74.1
	1974	25	27	92.6	35	35	100.0
	1975	29	33	87.9	42	45	93.3
	1976	34	39	87.2	49	55	89.1
Mean		29.00	34.46	84.1	40.64	51.91	79.6
Standard deviation		4.92	4.82	6.9	6.17	9.34	11.78
Coefficient of variation		17.0	14.0	8.2	15.2	18.0	14.8

Source: Halstead, 1978

[a] STB = stubble

[b] SMF = summerfallow

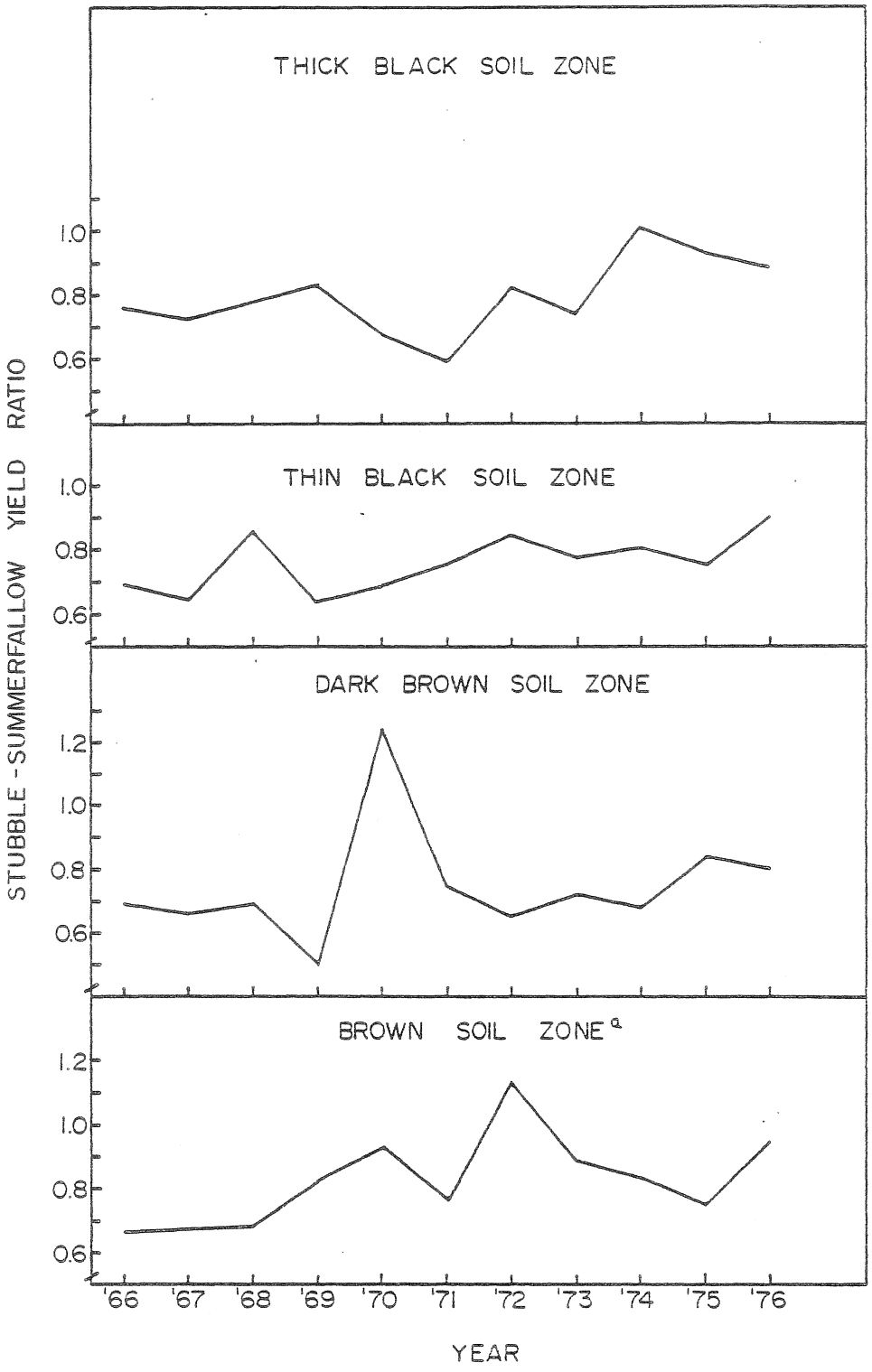
Figure 5. Stubble-Summerfallow Yield Ratios for Wheat by Soil Zone, 1966-1976



Source: Saskatchewan Institute of Pedology, "Unpublised Records of the Soil Testing Laboratory," University of Saskatchewan, Saskatoon.

[a] data are missing for 1970, Brown Soil Zone

Figure 6. Stubble-Summerfallow Yield Ratios for Barley by Soil Zone, 1966-1976



Source: Saskatchewan Institute of Pedology, "Unpublised Records of the Soil Testing Laboratory," University of Saskatchewan, Saskatoon.

[a] data are missing for 1970, Brown Soil Zone

Turning first to the case of wheat, the soil test data averaged across the soil zones (assuming equal weighting) results in an average stubble-summerfallow yield ratio of 82.2 percent. When the observations on the stubble-summerfallow yield ratios are averaged across soil zones on a yearly basis and then compared to Statistics Canada data for the same time period using a standard t-test, the differences are statistically significant at the 1 percent level. The difference between the ratios in favor of the soil test data is 13.7 percent. This difference corresponds to an advantage in the soil test results of more than 20 percent above the average from the Statistics Canada data[3]. Comparing the data by soil zone to the Statistics Canada data using the t-test, results in the data by soil zones all being statistically greater than the Statistics Canada data at the one percent level.

Statistical comparisons among the soil test data grouped by soil zone indicated that at the 5 percent level, the Thin Black yield ratio differed from that of the Thick Black yield ratio. At a 10 percent level of significance, the stubble-summerfallow yield ratio of the Dark Brown soil zone differed from that of the Thin Black. Consequently, even though the data from the soil zones collectively and separately by soil zone all differed significantly from the Statistics Canada data, there are significant differences among the soil zone data themselves. No additional analysis were conducted to determine if these differences were associated with agro-ecological differences among the zones or with managerial differences such as rate and type of fertilizer applied.

In the case of wheat, the differences between the two sets of data indicate that the stubble-summerfallow yield ratios are responsive to more intense levels of managment. This contradicts our earlier conclusions of neutrality based solely on the data from Statistics Canada. Ideally, we should be able to attribute at least part of this difference to the improved level of management and greater use of technological inputs attributed to farmers who test their soil. However, our data did not permit this detailed form of analysis.

The case for barley parallels that of wheat (table 4 and figure 6). When the data from the soil test records are averaged by year across the soil zones and compared to the data from Statistics Canada using a t-test, the results are statistically significant at the 1 percent level. The stubble-summerfallow yield ratios are consistently higher in the data from the Soil Testing Laboratory. On average, there was a difference of 10.3 percent in the yield ratio from the soil test data when compared to the data from Statistics Canada. This higher yield ratio represented a 14.5 percent improvement over the average of .716 ratio calculated for the data from Statistics Canada. In other words, those farmers who were soil testing were able to effectively increase their stubble-summerfallow yield ratios above the provincial norm. Although we lack production cost and product price

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[3] That is .137 is approximately 20 percent of the average stubble-summerfallow yield for the same period from the Statistics Canada data.

information, we can hypothesize that farmers testing their soil have a potential for a higher return from their stubble-seeded wheat and barley than is the norm for the province. The actual amount of this advantage has to be studied using crop budgets or other farm management techniques.

Unlike the data for wheat, not all of the barley yield ratios for the soil zones differed significantly from the data of Statistics Canada. Only the barley yield ratio from the Brown soil zone differed from the Statistics Canada data at the 1 percent level. The data from the Thick Black differed at the 2 percent level, while data from Thin Black differed significantly at the 10 percent level of significance. The Dark Brown soil zone's ratio of 74 percent did not differ significantly from the provincial data. Finally, even though the absolute levels of stubble and summerfallow yields differed among the soil zones, the analysis of variance and t-tests failed to detect significant differences among the soil zones in their stubble-summerfallow yield ratios. This lack of differences implies that the yield ratio is not affected by the agro-ecological differences represented by the soil zones. However, the higher level of management associated with farmers who soil test has lead to a general increase in the barley stubble-summerfallow yield ratio above the modal value for the province.

There are a number of conclusions we can draw from these descriptive and analytical statistics. These conclusions also point to a number of areas where additional agronomic and economic research should be carried out if we are to understand the physical and economic factor influencing these yield ratios. First, differences between data from Statistics Canada and the Saskatchewan Soil Testing Laboratory reflect probable differences in management and level of technology among provincial farmers as a group and those farmers engaged in soil testing. In general, farmers who soil tested obtained yield ratios of wheat that represent a 14 to 22 percent change above the provincial average. Similarly, farmers growing barley who soil tested had yield ratios 5 to 14 percent above the provincial norm. Unfortunately, we cannot meaningfully correlate these differences to specific management practices or types and levels of technology used by the farmers who tested their soil. The identification of management practices or specific kinds of technology which have contributed to the higher yield ratios is necessary in understanding how to elicit further increases in the ratios for the entire farming population. This is especially true given the existing agronomic concern for longer rotations, i.e., more stubble cropping. A parallel area requiring research is the economic factors underlying these differences in the yield ratios. Under present and expect costs of production and product prices are the higher ratios cost effective? Agro-economic analysis much be carried out if a policy of encouraging extended stubble cropping is to be adopted. Finally, an additional factor that could be contributing to higher yield ratios that requires investigation is experienced. Given that extended stubble cropping is rather new in Saskatchewa, there might be a learning factor involved on the part of farmers. Analysis of the data from soil test records indicates that those farmers who have been stubble cropping over a period of time experience stubble yield that first decline,

but then increase after 3 or more years[4]. These changes could be resulting from additional experience with techniques of stubble cropping and/or gradual changes in the soil associated with the practice.

The descriptive data indicate another general conclusion and a number of corollaries. The provincial data indicate that since 1958, there has not been a dominant trend of increasing stubble-summerfallow yield ratios. This time period coincides with a period of rapid technological advance and changes in Saskatchewan agriculture: increasing use of herbicides and fertilizer. However, these changes that have led to higher yields of cereal grains have not been reflected in the stubble-summerfallow yield ratios. The only exception has been those farmers who seemingly have been able to achieve a higher level of stubble-summerfallow yield ratios, i.e., those soil testing. However, even this latter group has not experienced increasing yield ratios over the period of study. Consequently, in light of agricultural policies that encourage the adoption of more and longer-term stubble cropping, we need research into the underlying agronomic and economic factors affecting these ratios and their rates of change. Such research is necessary if we are to be able to predict further productivity under different systems of crop management.

In summary, data on stubble-summerfallow yield ratios from two sources were studied. The analysis indicated that the ratios have remained remarkably constant over time and across soil zones. The analysis also showed that presumably higher levels of management have led to higher yield ratios. However, these changes could not be correlated to any specific managerial factors.

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[4] This occurs more commonly in the Dark Brown, Thin Black and Thick Black soil zones where moisture limitations on production are not as constraining as in the Brown soil zone, see Halstead, 1978.

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